Complex Parallel Bi-conjugate Gradient Method on Electromagnetic FEM

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ABSTRACT

As one of most popular solutions on complex or coupled problems, the finite element method (FEM) has exhibited large superiorities on describing detailedly and analysing accurately the electromagnetic and its coupled fields. Furthermore, vector elements [1], conformal absorbing boundary [2], domain decomposition and mixed methods [1] etc., which are introduced successfully into the electromagnetic FEM, provide some feasible approaches for the computation and analysis of large-scale electromagnetic fields.

Otherwise, the core solving methods of large-scale complex linear systems are not so powerful in the electromagnetic FEM. Although some valid complex iterative methods based on traditional real iterative methods [3,4] are recently presented to save the computational resource, it is still an knotty problem how to improve the solving efficiency.

Here, in view of the advantage of bi-conjugate gradient algorithm [1] for complex linear systems, we propose a parallel scheme based on the complex bi-conjugate gradient algorithm for the large-scale electromagnetic FEM. In one iteration of this scheme, the inner product operation and multiply operation between vectors and matrixes, which cost a large amount of computation and memory effort, will be distributed efficiently to multi-threads or multi-processors. Numerical experiments proved its high-efficiency and reliability (the complex parallel bi-conjugate gradient method converges with much fewer iterations and less time than other iterative methods).

Because of the simple parallel structure and very low hardware requirement, the complex parallel bi-conjugate gradient method shows a feasibility that the large-scale electromagnetic problems can be analysed and solved by a parallel cluster of personal computers or small workstations.

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